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¬Numerical Design of Porous Materials Using Adjustable Level-Cut Poison Field Method

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Despite recent advances in synthesis and manufacturing of porous materials and devices, producing porous structures with targeted properties is still an expensive, trial-and-error procedure. Numerical porous media design is one of the possible ways to accelerate this process and to guide manufacturing.
Current numerical porous media design methodologies often include a random microstructure generator nested within an optimization routine. At each iteration, the optimization algorithm compares properties of the microstructure with desired target properties, such as permeability, porosity and pore size distribution, and adjusts the inputs to the generator accordingly. A considerable drawback of this approach is computational cost, which is mainly due to the time needed to generate a completely new microstructure at each iteration.
To address this problem, we propose the Adjustable Level-Cut Poison Field (ALCPF) method, a new approach based on the level-cut Poisson field theory [Grigoriu, 2003]. First, several initial domains are generated based on set of filtered Poisson field parameters. Then, rather than generating a completely new filtered Poisson field, the optimization algorithm takes a weighted geometric average of the initial domains to produce a new filtered Poisson field. The process is repeated until an optimal domain is found, with a dramatic reduction in computational time.
The weighted geometric averaging also has an added advantage of spatial control over the material microstructure. By adjusting the weights of the geometric mean throughout the initial domains, an inhomogeneous virtual material with desired microstructure can be generated.

References

Grigoriu, M.: Random field models for two-phase microstructures. J. Appl. Phys. 94, 3762–3770 (2003).

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